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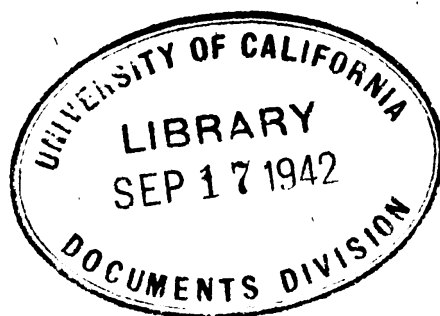
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WAR DEPARTMENT

TECHNICAL MANUAL

**ORDNANCE MAINTENANCE
PLOTING BOARDS
FOR FIELD ARTILLERY**

May 21, 1942



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WASHINGTON, May 21, 1942.

ORDNANCE MAINTENANCE

PLOTTING BOARDS FOR FIELD ARTILLERY

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SECTION I

INTRODUCTION

1. **Scope.**—This manual is published for the information and guidance of ordnance maintenance personnel. It contains detailed instructions for inspection, disassembly, assembly, maintenance, and repair of plotting boards for Field Artillery, supplementary to those in the Technical Manuals prepared for the using arm. Additional descriptive matter and illustrations are included to aid in providing a complete working knowledge of the matériel.

SECTION II

BOARD, PLOTTING, SOUND RANGING, M1

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2. **General.**—The sound ranging plotting board M1 is the standard board for use by the Field Artillery in determining the location of a sound source from sound ranging operations.

3. **Description.**—This plotting board (figs. 1 to 7 incl.) consists essentially of a frame, two carriages, a range asymptote arm, and the necessary plotting surfaces, platens, and correction charts.

a. The frame is supported by four legs. The time-difference scale, containing five different scales, is attached to the frame on one side

and the bracket for the asymptote arm pivot on the other. Provision is made on the frame for receiving either the straight-base or curved-base carriage. The straight-base carriage can be moved back and forth across the frame on rollers while the curved-base carriage pivots about a spindle mounted in the frame. A locking and locating mechanism, attached to the frame, holds either carriage in its proper position. This mechanism can be operated from front or rear of the board by means of levers connected to it.

b. The straight-base carriage, used when the microphone stations are in a straight line, includes a lower plate with rollers, the plotting plate, and platens. Six vertical rollers attached to the lower side of the carriage provide support and a means of moving the carriage on the frame. Four platens are furnished with the straight-base carriage, one for each subbase length of 4.0, 4.5, 5.0, and 5.5 seconds. Each platen contains seven tapered holes, located accurately in a straight line to agree with the midpoints of the corresponding subbase lengths of the microphone stations. The plotting plate, C56568, is clamped to the upper side of the carriage. It is easily detachable.

c. The curved-base carriage, used when the microphone stations are not in a straight line, includes a lower plate with spindle, a plotting plate, and platens. This carriage pivots about a spindle attached to the frame and is provided with an adapter containing three radial holes so that it can be mounted to swing in an arc whose radius corresponds to the radius of the microphone stations. When the 25-second radius is used, the spindle is inserted in the hole in the frame nearest the bracket and the carriage is mounted using the bearing nearest the bracket. When changing to the 30-second radius, the retainer, A40270, (fig. 4) is interchanged with the disk retaining the second bearing. The spindle is inserted in the middle hole in the frame and the carriage mounted accordingly. When using the 35-second radius the third hole in the frame and adapter is used. Eight platens are supplied for use with the curved-base carriage. Two are used with the 25-second radius, three with the 30-second radius and three with the 35-second radius. The plotting plate, C56567, (fig. 4) is clamped on top of the carriage. It is easily detachable.

d. The range asymptote arm pivots about the microphone center, assembly on the bracket and can be swung through an angle of 120° . On the outer end of this arm is a clamping mechanism and an index. An adjustable cover covers up all the scales on the time-difference scale except the one being used. The clamping mechanism is so designed that by pressing the clamping lever the clamp is released and the arm can be rotated to the desired reading. When the lever

is released, the spring forces the lever back to its normal position, clamping the support to the rail.

e. Five correction charts, one temperature correction chart, and four asymptote correction charts facilitate determination of the necessary

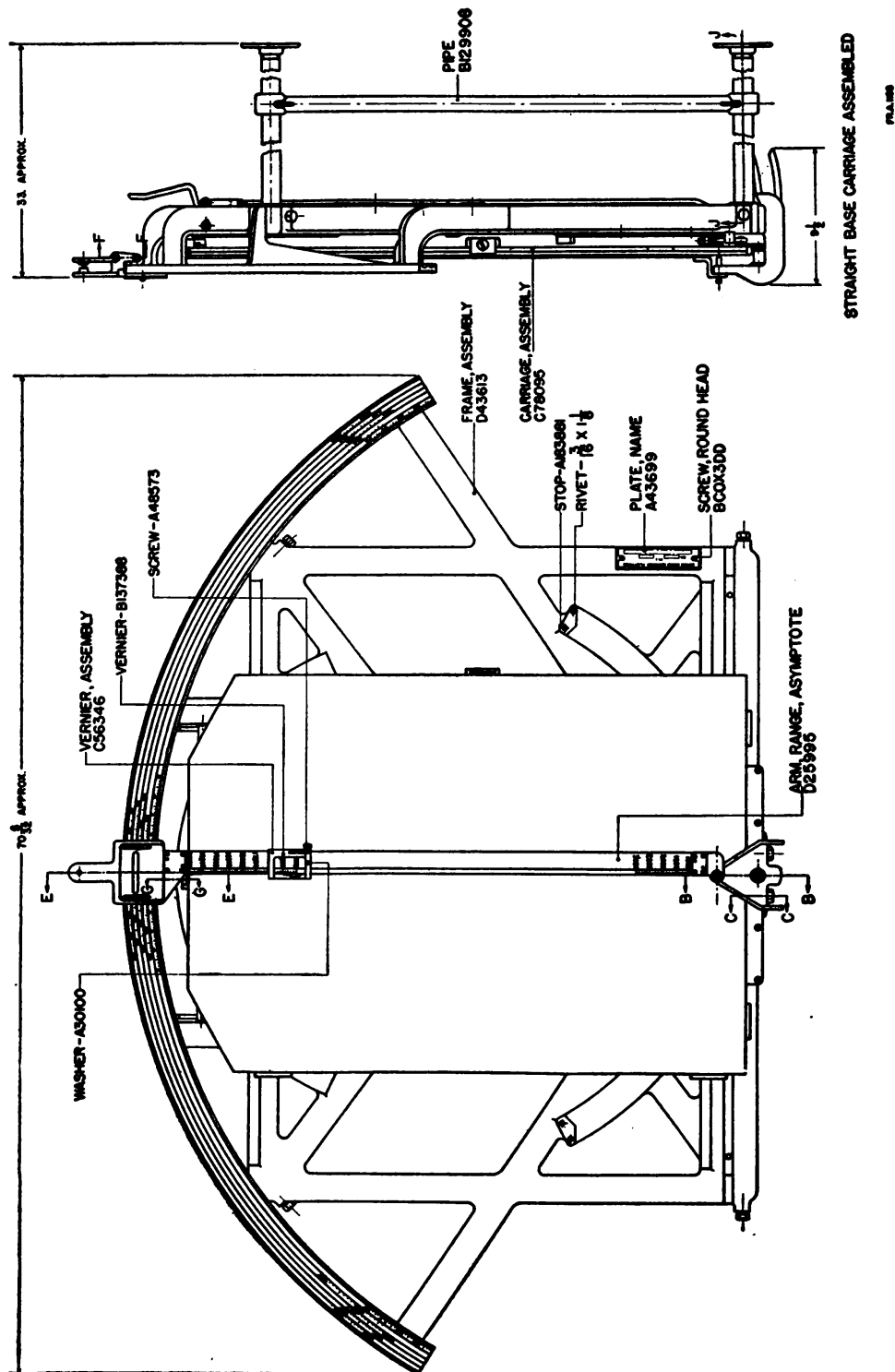


FIGURE 1.—Board, plotting, sound ranging, M1, with straight base carriage—assembled views.

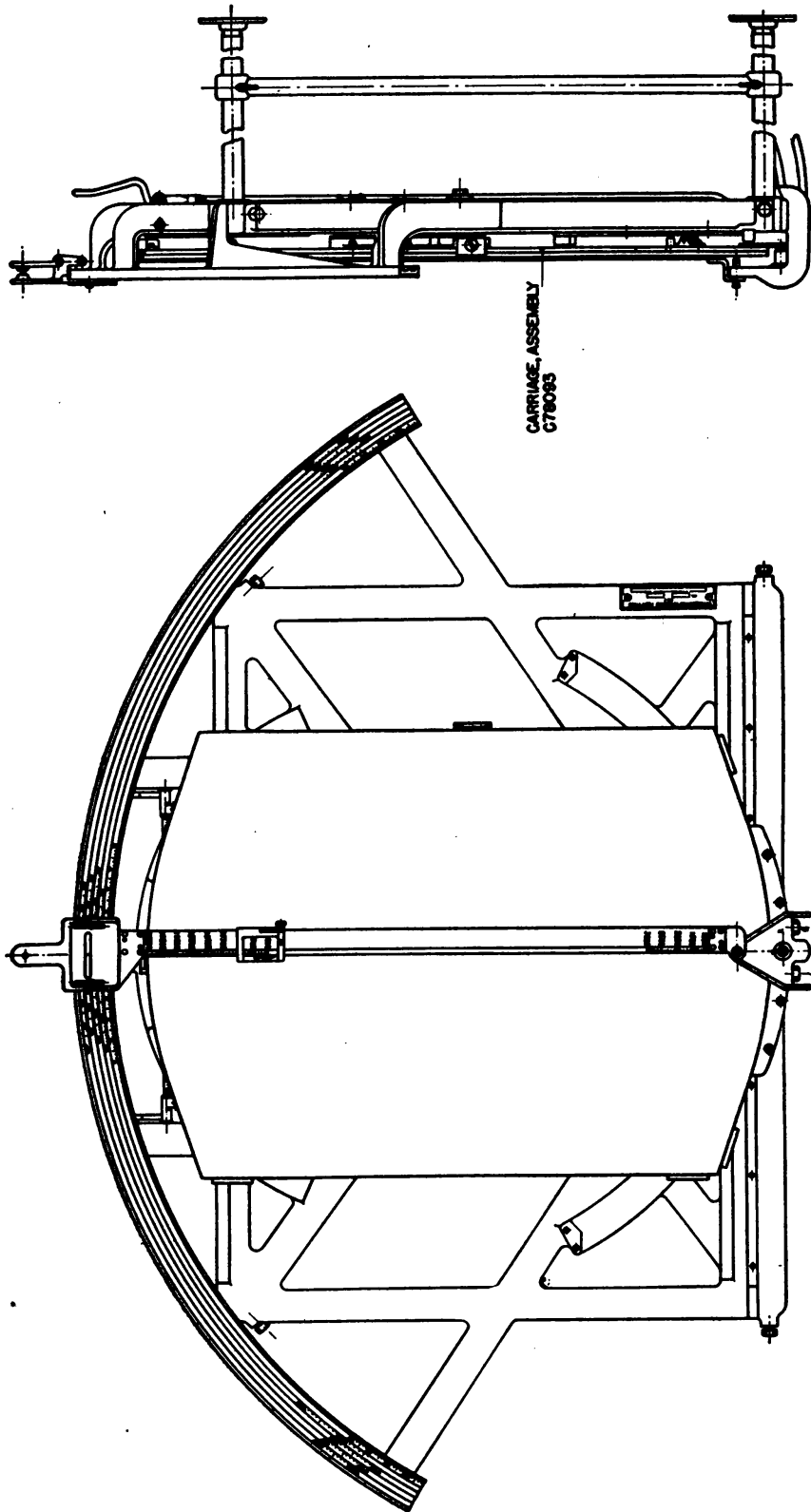


FIGURE 2.—Board, plotting, sound ranging, M1, with curved base carriage—assembled views.

corrections. These charts are nomographs and are printed on white "Vinylite" sheets.

f. Each instrument is supplied with a packing chest, accessory chest, weatherproof cover, and tools. The packing chest is used for storing the frame, one of the carriages, the legs, range arm, and tools. The accessory chest is used to store the extra platens, the carriage not in use, and the cover.

4. Operation.—*a.* Make sure that the frame rests firmly on the legs and that the four bolts, BCAX1EC, (fig. 7, sec. J-J) holding the legs in the frame, are tightened securely.

b. If the straight-base system is used, mount the straight-base carriage, with the platen corresponding to the length of the microphone subbase used, to the frames so that it rides along the guide rail. If the curved-base system is used, mount the spindle in position corresponding to the radius being used. Attach the proper platen to the carriage.

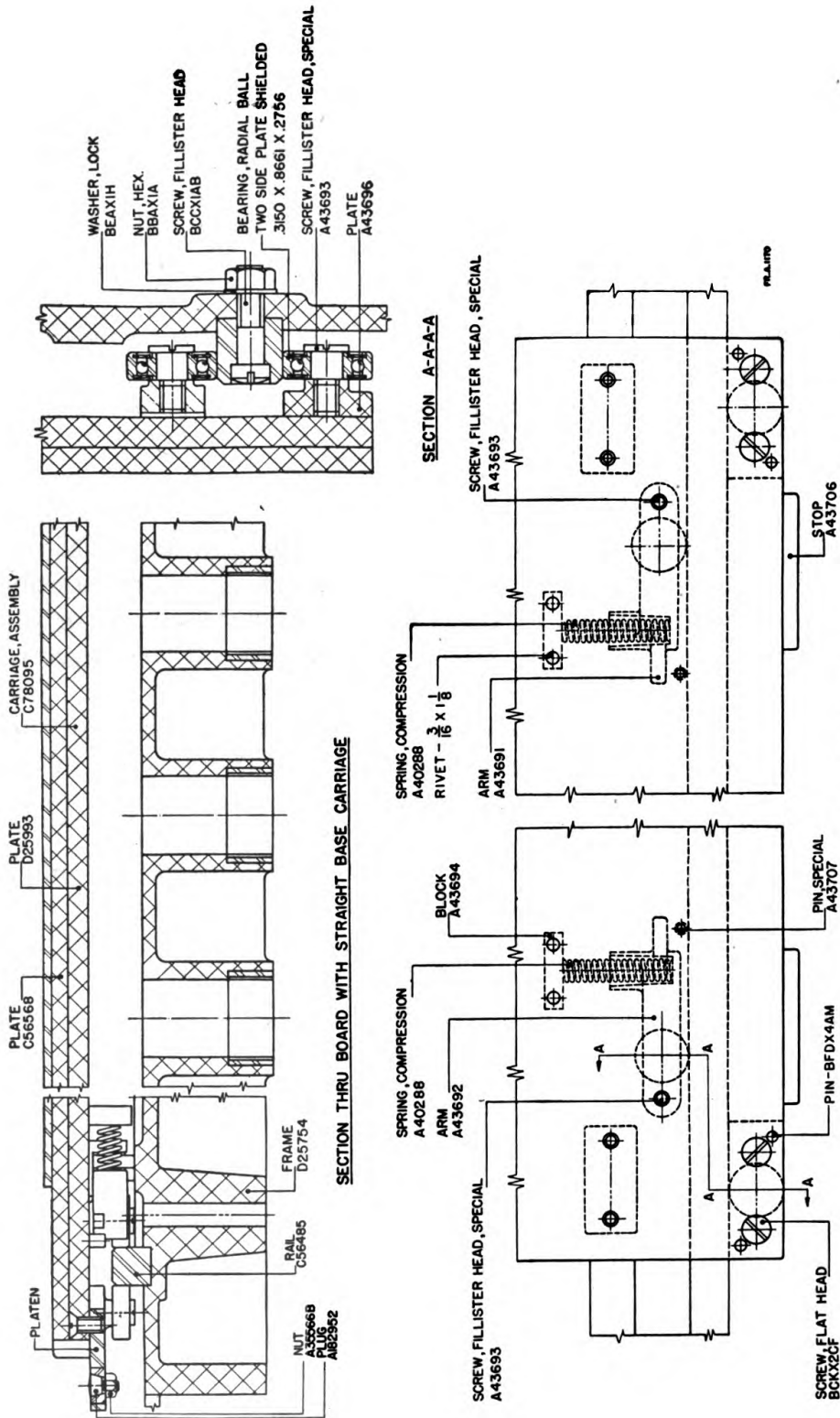
c. Place the range arm on its pivot on the bracket. Exercise care that the spring between the arm support and the clamping lever is centered in the cup of the lever and that the clamping shoe is in a vertical position before attempting to slide the arm over the rail.

d. Draw the grid on the paper according to the surveyed positions of the microphones. Plotting can be done either directly on the aluminum plotting plate or on a piece of vellum attached to the plate. Vellum is used when a permanent record is desired.

e. The oscillogram reader computes the time intervals from his readings. The uncorrected time intervals are then laid off on the time-difference scale by the arm setter and the asymptotes drawn as follows:

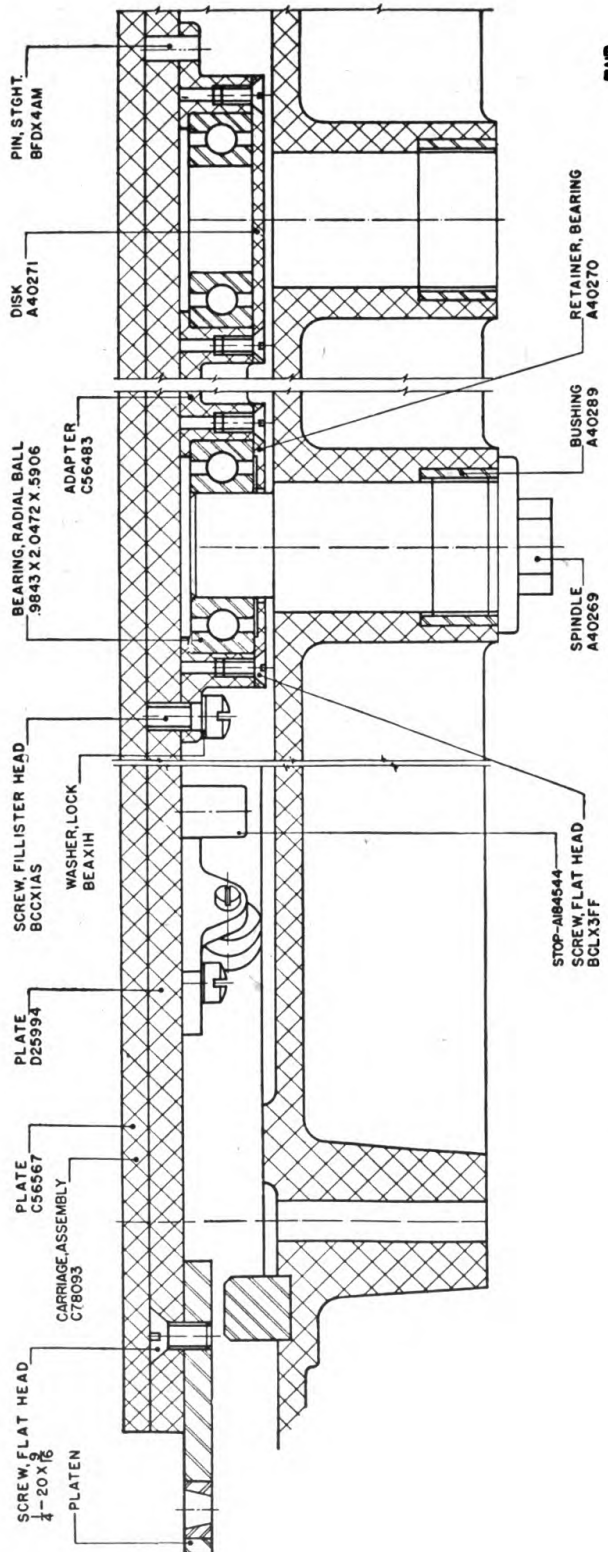
(1) Depress the locking lever, B129907 (fig. 5, sec. B-B) and slide or rotate the carriage until the plunger in the locating mechanism is above the hole in the platen corresponding to the midpoint between the two microphone stations. Release the locking lever, locking the carriage in position.

(2) Set off the time difference for the point by rotating the range arm (the arm clamp being first released) until the wire index in the arm coincides with the required reading on the time-difference scale. Clamp the arm in position and draw the asymptote along the beveled edge of the range arm. This procedure is repeated for each point for which a time-difference is available. The intersection of the asymptotes will indicate the plotted (uncorrected) position of the sound source.



PLAN VIEW SHOWING ROLLER MECHANISM

FIGURE 3.—Board, plotting, sound ranging, M1—plan and sectioned views.



SECTION THRU BOARD WITH CURVED BASE CARRIAGE

FIGURE 4.—Board, plotting, sound ranging, M1—sectioned view.

f. Corrections.—To locate the sound source accurately, corrections for wind, temperature and asymptote must be made. Temperature and asymptote corrections are determined from charts. The wind correction may be solved mechanically by the use of the sound ranging wind corrector M1 (sec. III). After the corrected time dif-

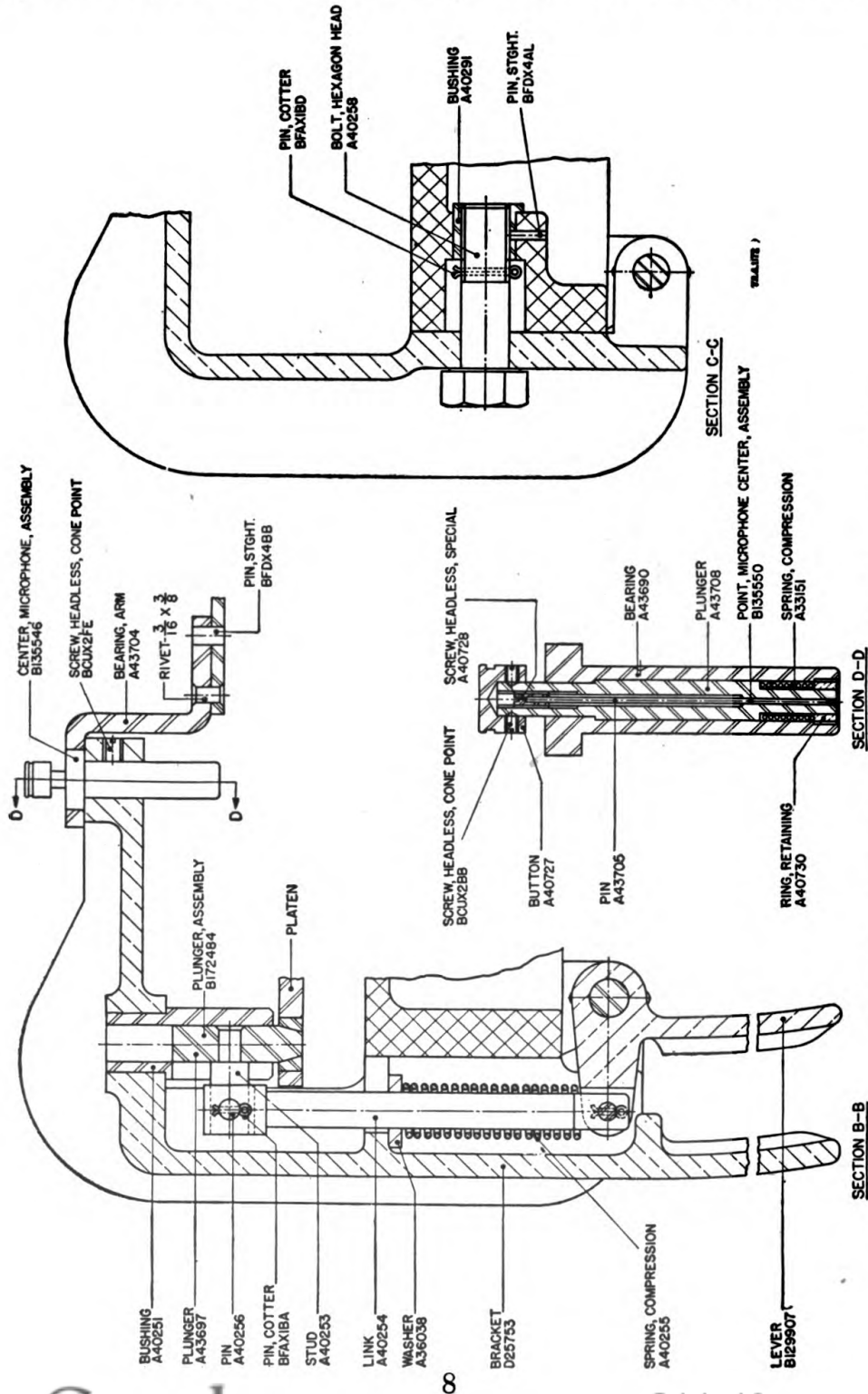
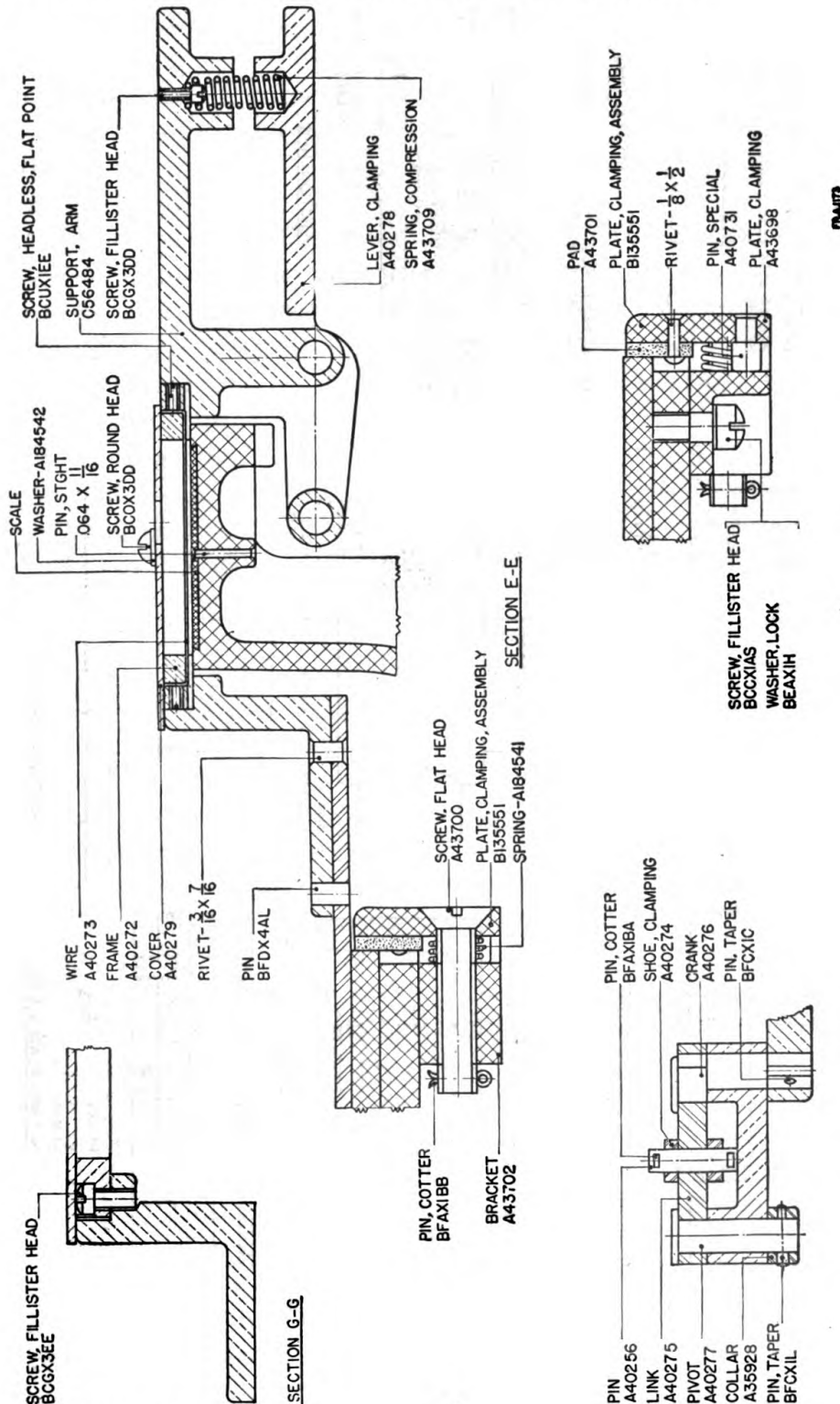


FIGURE 5.—Board, plotting, sound ranging, M1—sectioned views.

ference for each midpoint has been determined, the draftsman prepares a corrected plot. Usually the asymptotes will not intersect at a point but will form a polygon. Location of the sound source is then taken as the center of gravity of this polygon.



SECTION THRU PLATE CLAMPING DEVICE

FIGURE 6.—Board plotting, sound ranging, M1—sectioned views,

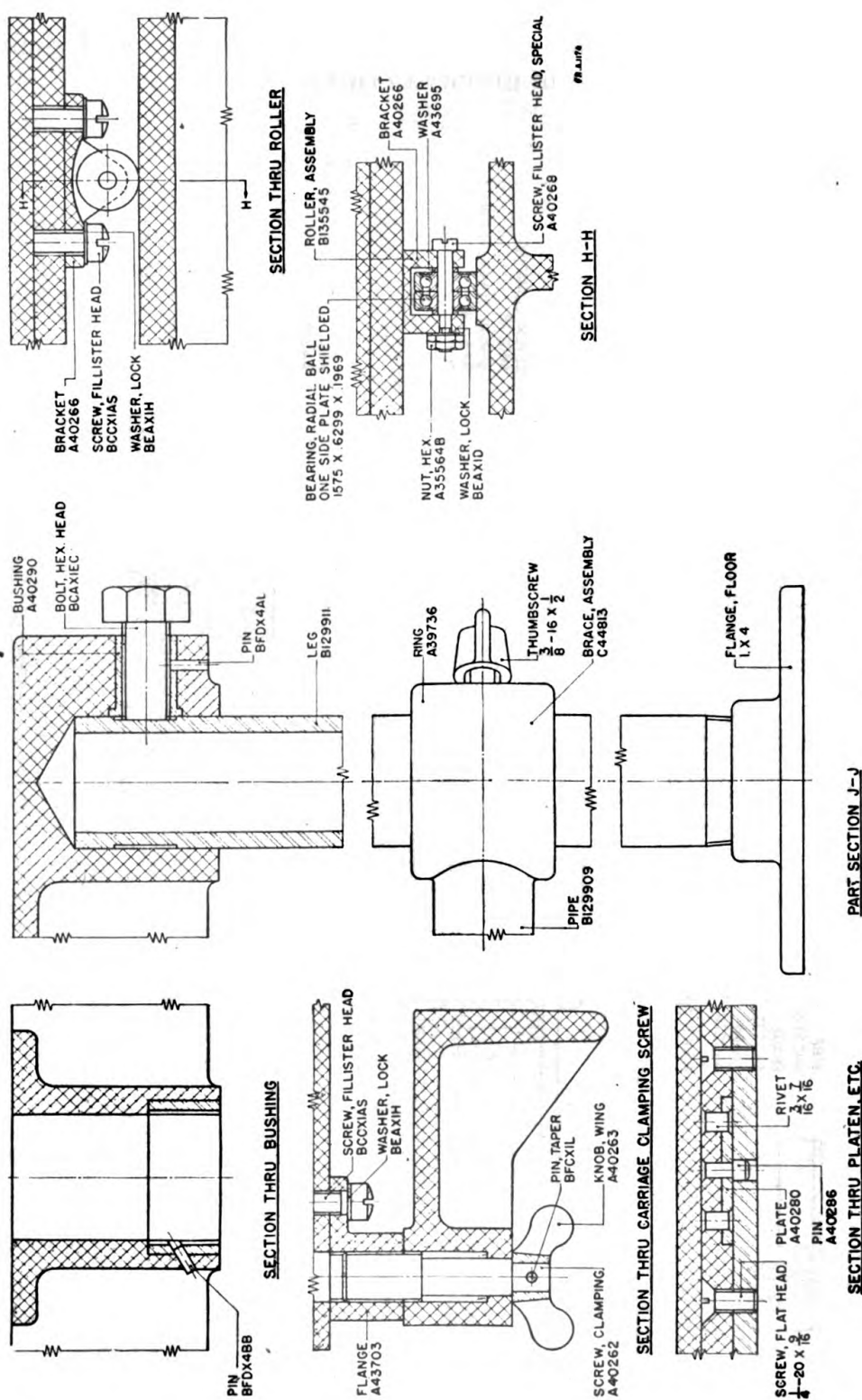


FIGURE 7.—Board, plotting, sound ranging, M1—sectioned views.

SECTION III

CORRECTOR, WIND, SOUND RANGING, M1.

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5. General.—The sound ranging wind corrector M1 is issued with the sound ranging plotting board M1 to solve the wind corrections graphically, that is, to determine the time-difference increment in value and sign.

6. Description.—The sound ranging wind corrector M1 (fig. 8) includes a central disk, correction scale, azimuth ring, and wind arm.

a. The correction scale is a circular plate with engraved lines to represent time corrections in seconds. Each line represents .005 and every other line is numbered, representing .010 sec. The azimuth scale, C44886 (fig. 8, sec. A-A), contains a scale to indicate the azimuth of the subbase and an outer scale or wind-direction scale for setting off the azimuth of the wind. Subbase markers are provided for setting in the azimuth of the subbase.

b. The wind arm pivots about the special fillister head screw, A40304. A clamping screw, A40306 (fig. 8, sec. A-A), on the outer end is used for rotating and clamping the arm to any desired position. Two scales are provided with the arm. Each scale is engraved with two sets of graduations representing the wind velocity for the respective subbase lengths.

c. Each instrument is furnished with a packing chest, accessory chest, weatherproof cover, and necessary tools.

7. Operation.—*a.* Set the base marker to the azimuth of the subbase. Orient the subbase scale by turning the correction disk until the index on the disk appears opposite the index on the proper subbase marker. Set the wind arm to the azimuth of wind direction.

b. Read the wind correction in seconds on the correction scale opposite the wind velocity on the wind arm. The algebraic sign of the correction indicated on the disk conforms to the convention followed on the plotting board time-difference scale. The sign of the correction is true only if the azimuth of the subbase is read from observation station M2 to observation station M1, when the locations of these stations for the subbase are so chosen that the sound wave from the unknown sound source reaches station M1 before it reaches station M2. Care must be exercised that the scale corresponding to the subbase length being used is attached to the wind arm so that it reads from the center of the disk outward.

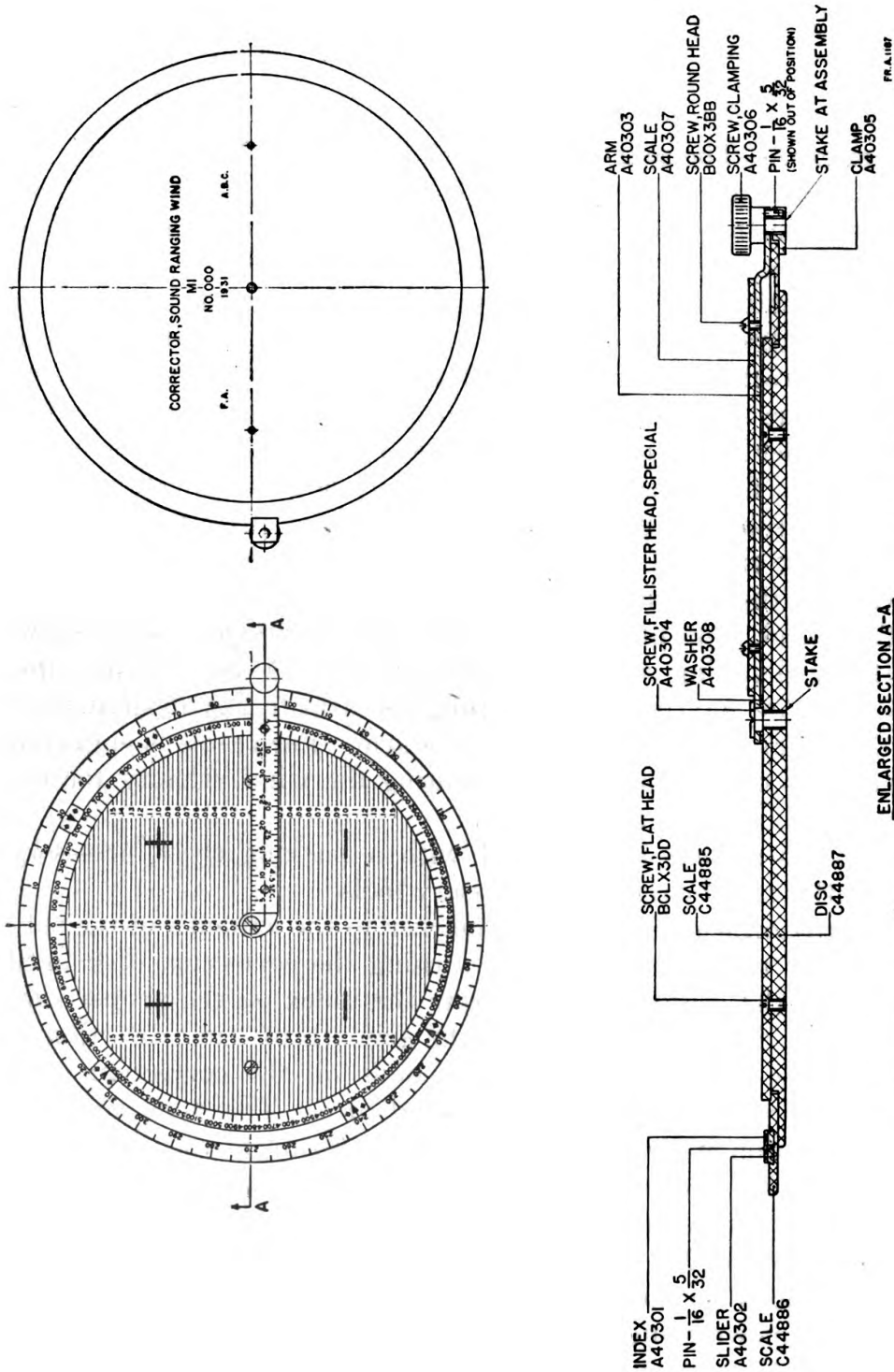


FIGURE 8.—Corrector, wind, sound ranging, M1—assembly and sectioned views.

SECTION IV

BOARD, PLOTTING, M5

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8. General.—Plotting board M5 is the standard for the flash ranging plotting board requirement. This board is used by the flash ranging platoon of observation batteries of the Field Artillery.

9. Description.—Plotting board M5 (figs. 9 to 11 incl.) consists of a rotating table with a grid engraved on its top surface, a drafting machine with a graduated straight edge attached, and a supporting base and legs. An azimuth scale, graduated in mils, is attached to the periphery of the table. A slow-motion and braking mechanism is provided on this table. A packing chest is supplied with this equipment.

10. Operation.—Operation of the plotting board requires two men. One rotates the plotting table to the announced azimuths and the other operates the drafting machine, plots the positions as set off on the azimuth scale with respect to the grid lines and observation posts, and scales the distances.

a. Orientation.—Orient the plotting board by pressing the brake lever and rotating the table until the graduated edge of the scale coincides with the north-south grid line and the zero on the azimuth scale coincides with the zero on the vernier. To get exact coincidence of the zeros, clamp the table by releasing the brake lever and rotate the slow-motion knob until this condition is obtained.

b. Setting off azimuth.—(1) Set off the announced azimuth by pressing the brake lever and moving the table the desired amount. Final adjustment is obtained by rotating the slow-motion knob.

(2) Plot the observation station positions by means of X and Y coordinates. Draw a line through each observation station position at the azimuth received from the corresponding station of the observed flash. The intersection of these lines as plotted will mark the position of the target as observed. The X and Y coordinates of this point can be determined by referring to the grid origin and scaling the distances to each axis. In actual practice, six sets of observations are plotted (if possible) and a mean point determined.

c. High-burst ranging and center of impact adjustments.—For targets of great importance the plotting board M5 is used to locate the center of bursts.

(1) Plot the coordinates of the observation posts.

(2) One round is fired and the azimuths are reported and plotted. The coordinates of this point are not recorded since it is plotted only as a check to see if each observer is sighting properly on the same burst.

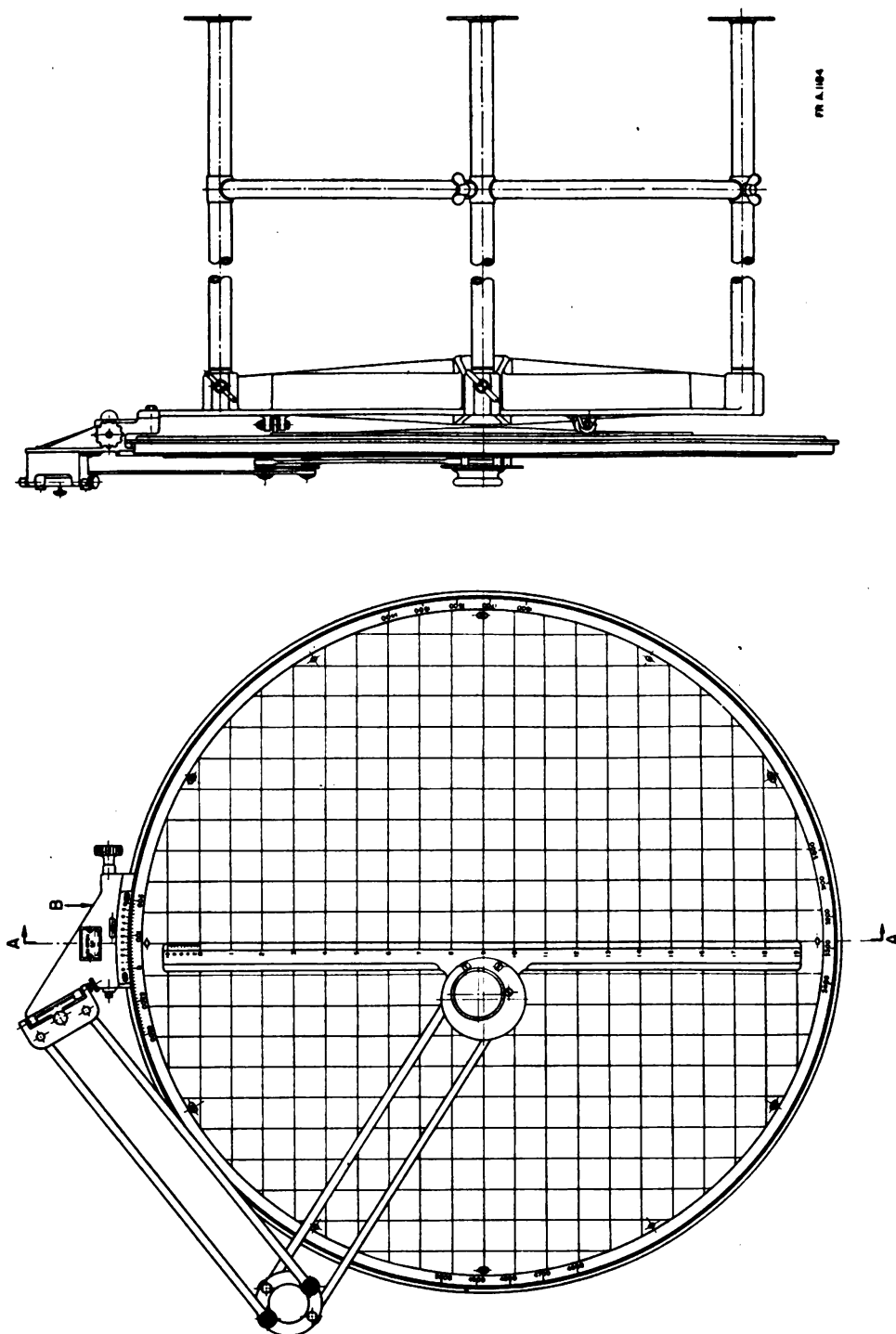


FIGURE 9.—Board, plotting, M5—assembly views.

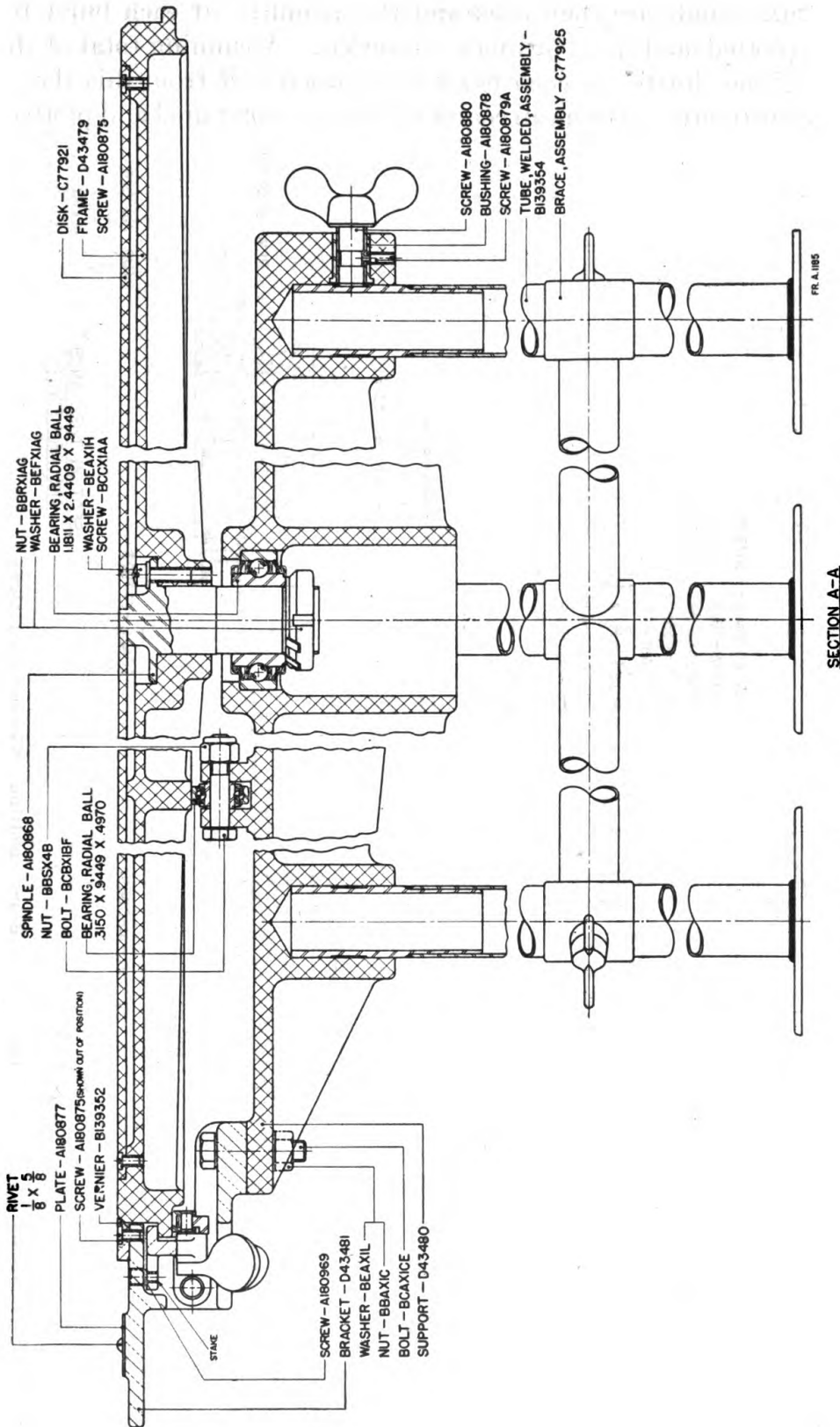


FIGURE 10.—Board, plotting, M5—sectioned view.

(3) Six rounds are then fired and the azimuths of each burst reported, plotted, and the coordinates recorded. A running total of the *X* and *Y* coordinates of each burst is recorded and from this the *X* and *Y* coordinates of the mean center of bursts is computed and plotted.

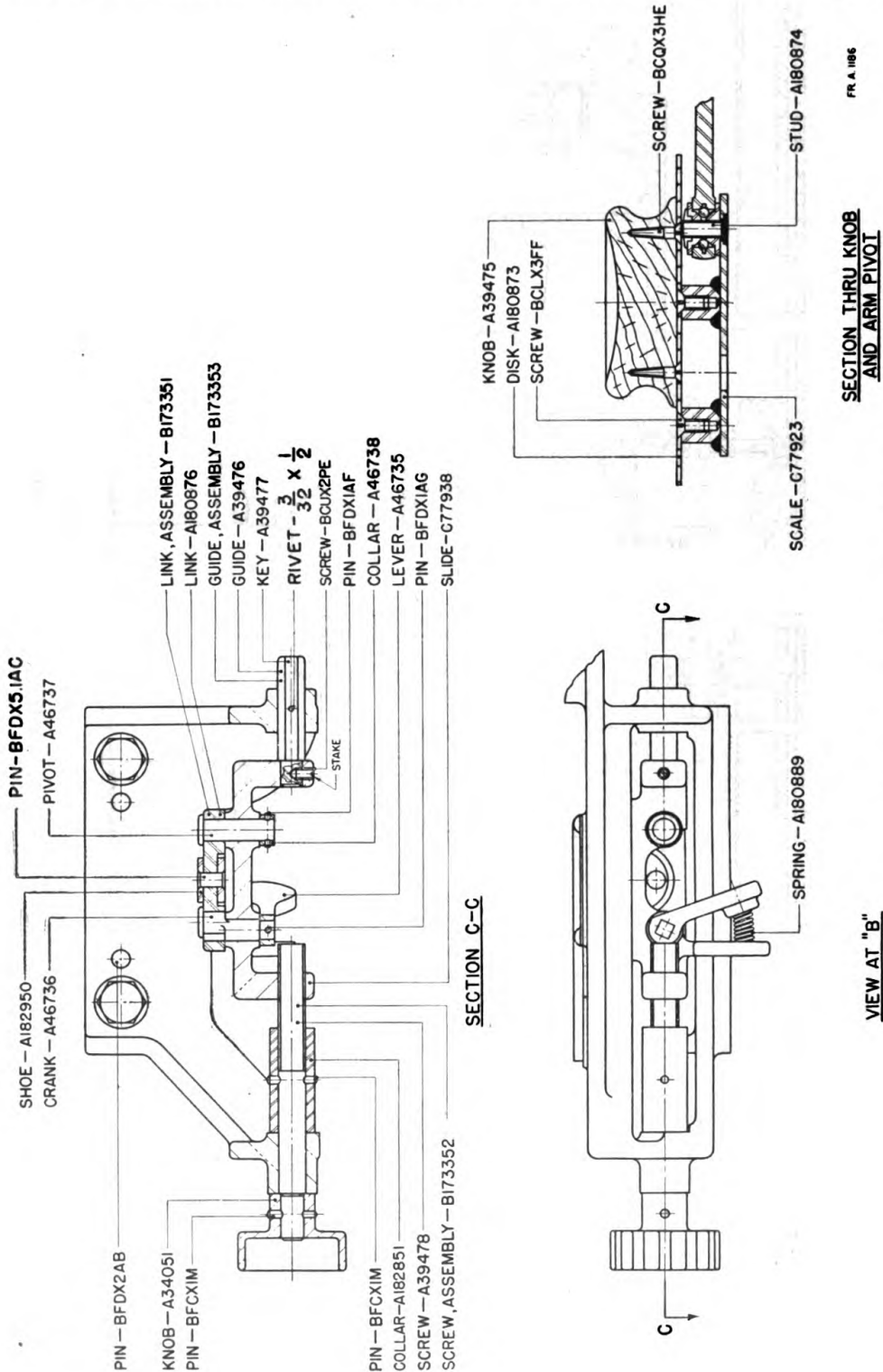


FIGURE 11.—Board, plotting, M5—sectioned views.

VIEW AT "B"

SECTION V

MAINTENANCE AND REPAIR

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11. Inspection.—Inspection is for the purpose of determining the condition of the matériel, whether repairs or adjustments are required and the remedies necessary to insure serviceability and proper functioning. The following list will serve as a guide:

a. General.

Parts to be inspected

Points to be observed

(1) External parts.

(1) Examine the matériel as a whole for loose and missing parts such as screws, nuts, knobs, and scales. See whether the graduation on the scales is legible.

(2) Rotating disks and scales.

(2) Examine these parts by rotating them 360°. Observe whether they run true. Note any sticking or undue looseness which will interfere with the proper functioning of the instrument.

b. Board, plotting, sound ranging, M1.

(1) Movable carriages.

(1) Release the platen locking device and move the movable carriage to the limit of its lateral travel (or rotation) in each direction. Observe whether this movement is smooth without undue friction or looseness.

(2) Platen clamping and asymptote arm clamping mechanisms.

(2) Operate the clamping lever, B129907, (fig. 5, sec. B-B) and clamping lever A40278, (fig. 6, sec. E-E) and observe whether or not each functions properly. Failure of these mechanisms to function properly may be due to weak compression springs or worn moving parts.

(3) Range asymptote arm and pivot bearing.

(3) See that the asymptote arm is not bent and that it swings freely about the pivot. Swing the arm to the extreme right and remove from

*Parts to be inspected**Points to be observed**c. Board, plotting, M5.*

(1) Plotting scale and drafting machine.

(2) Slow-motion and braking mechanism.

the board. Examine the pivot bearing, A43690, (fig. 5, sec. D-D) to see whether the bearing surface is smooth and the bearing firmly set in the bracket, D25753.

(1) See whether the plotting scale is bent or nicked. Operate the drafting machine. Observe any sticking or undue looseness in the moving parts.

(2) Operate the brake lever to see whether it functions properly. The slow-motion-mechanism should operate smoothly and without undue friction or looseness.

12. Tools for maintenance.—Included with this matériel are such accessories as screw drivers, wrenches, brushes, etc., for use in adjusting and repairing. Other tools which may be necessary are usually found in tool kits of ordnance maintenance shops.

13. Adjustments.—*a. Board, plotting, sound ranging, M1.*—(1) To adjust the microphone center point. Remove the microphone center button, A40727, (fig. 5, sec. D-D) by first loosening the two cone point headless screws, BCUX2BB. With a screw driver adjust the special headless screw, A40728, until the desired prick punch hole is obtained. Replace the microphone center button and tighten the cone point screws.

(2) To adjust the asymptote arm support wire index. Remove the cover, A40279 (fig. 6, sec. E-E). Loosen the screws, BCGX3EE, (fig. 6, sec. G-G) and slide the frame, A40272, until the index wire, A40273, is in line with the beveled edge of the asymptote range arm. Tighten the screws and replace the cover.

b. Board, plotting, M5.—(1) To adjust the plotting board vernier. Rotate the table until the central Y-grid line coincides with the edge of the plotting scale. Loosen the two special screws, A180875, and shift the vernier, B139352, (fig. 10) until the zero on the vernier is opposite the zero on the azimuth scale. If it is impossible to obtain this position, the plotting grid disk, C77921, may be out of adjustment. To adjust, loosen the six special screws, A180875, (fig. 10, sec. A-A) temporarily and shift the disk the required amount.

(2) To adjust the drafting machine plotting scale. Loosen or tighten the adjusting thumbscrew (whichever may be necessary) until the plotting scale is the desired distance from the plotting board.

14. Disassembly and assembly.—The assembled and sectioned views show the location of the various parts and the means by which they are held in place. These figures should be studied carefully before attempting any disassembling operation.

a. Board, plotting, sound ranging, M1.—(1) To disassemble the range asymptote arm assembly. Remove the clamping lever, A40278, by driving out the associated pin. Remove the clamp compression spring, A43709, (fig. 6, sec. E-E) by unscrewing the fillister head screw, BCGX3DD. Carefully lift the arm assembly from the board. Access can now be had for disassembling of the arm bearing, A43704, and arm support, C56484, if necessary.

(2) To disassemble the carriage locking mechanism. Remove the asymptote arm from its pivot by releasing the arm clamping lever, swinging the arm to the extreme right and lifting vertically upward. Unscrew the two hexagon head bolts, A40291, (fig. 5, sec. C-C) and swing the bracket, D25753, (fig. 5, sec. B-B) away from the board. Remove the plunger, A43697, by first removing the pin, A40256, and associated cotter pin. The link, A40254, together with compression spring, A40255, may be removed by first removing the pin from the lower part of the plunger. Access for disassembling other parts of the mechanism can now be had if necessary.

(3) To change platens. The procedure for installing platens on the curved-base carriage is similar and therefore is not given.

(a) Remove the range asymptote arm from the board by swinging the arm to the extreme right and lifting the arm vertically upward.

(b) Release the carriage locking mechanism and move the carriage to the limit of its motion away from the locking plunger, assembly, B172484, (fig. 5, sec. B-B). Remove the plotting plate, C56568, by releasing the associated clamps. Remove the platen by removing the flat head screws, $\frac{1}{4}$ -20 x $\frac{9}{16}$ (fig. 7).

(c) Place the desired platen in position. Before tightening the platen screws, the platens should be located accurately on the board by means of the dowel pins. Replace the plotting plate, C56568. Release the locking mechanism and move the carriage to the desired position.

b. Corrector, wind, sound ranging, M1.—(1) To disassemble the various component parts. Remove the wind arm by unscrewing the clamping screw, A40306, (fig. 8) and the special fillister head screw, A40304, with washer, A40308. Remove the central scale, C44885, by first removing the two flat head screws, BCLX3DD. The

azimuth scale, C44886, together with the slider indexes, A40301, may now be removed.

(2) When assembling, lubricate the moving parts sparingly with oil and tighten the various screws and knobs so that the slider indexes and asymptote range arm can be moved without undue friction or looseness.

c. Board, plotting, M5.—To disassemble the slow-motion mechanism. Remove the slow-motion knob by driving out the pin, BFCX1M (fig. 11, sec. C-C). Extract the cotter pin, BFCX1M, from the collar, A182851. Unscrew the slow-motion screw from the slide, C77938. Loosen the headless locking screw, BCUX2PE, and the screw, A180969, (fig. 10, sec. A-A) and remove the slide, C77938, with associated parts from the bracket.

d. Assembly.—The procedure for reassembling is the same as for disassembling except in the reverse order. When reassembling all movable parts should be lubricated sparingly with oil.

SECTION VI

CARE AND PRESERVATION

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15. Lubrication.—*a.* All bearings and sliding parts, such as riders and movable platens, should be lubricated sparingly with a few drops of oil.

b. Threads of the clamping screws and of the slow-motion mechanism should be lubricated lightly with oil.

c. Oil cups are provided for lubricating the bearings and worm gears of the equipment. These parts should be lubricated at intervals, depending upon service conditions.

d. Oil, lubricating, for aircraft instruments and machine guns, is the only lubricant and rust preventive to be used on this matériel.

16. Care in handling.—*a.* This equipment, with ordinary care, will be serviceable for a long time but it will not stand abuse.

b. The board should be wiped occasionally with a soft, dry cloth to keep it free from dust and grit. To prevent accumulation of dust and grit, wipe off any excess grease or oil that seeps from the mechanisms or bearings.

c. Avoid denting or chipping the beveled edges of the scales and the surfaces of the platens, plotting boards or plotting disks.

d. When changing platens, the screws fastening the platen to the carriage plate should be tightened securely. Special care should be

exercised in the handling of platens as any damage affecting the positioning or shape of the tapered holes will impair the accuracy of the plotting board.

e. When tightening the various screws and knobs, exercise care that they are tightened just enough to insure a snug fit, as too much pressure might damage the threads or injure the platen, plates, etc.

f. Do not attempt to move the asymptote range arm without first releasing the clamp.

g. When attempting to shift the carriage, the platen locking plunger should be disengaged completely from the platen. Any attempt to move the carriage without disengaging the locking plunger properly will in time bur the edges of the locating holes and impair the accuracy of the board.

h. Do not lean on brackets or pivots, or subject the equipment to unusual strains as these will cause misalignment and impair the accuracy of the board.

i. The range asymptote arm and the associated pivot contain accurate machined surfaces. Exercise extreme care that none of these surfaces are nicked or burred.

j. Make frequent examinations to see that the brackets supporting plotting arms are secured fast to the frame.

k. Correction charts are made of inflammable material. Exercise care in handling them.

l. Keep the clamping screws on the legs and braces tight at all times.

17. Storage.—Instruments being stored or transported should be placed in the packing chest provided.

a. The arms and extra platens should be stored in the racks provided in the packing chest.

b. The instrument should always be stored in a dry place; if exposed to wet weather the parts should be wiped thoroughly dry before being placed in the chests for storage or transportation.

c. The plotting board clamping screws should be tightened firmly when the board is stored or transported.

APPENDIX

REFERENCES

1. Standard Nomenclature Lists.

- a. Cleaning and preserving materials----- SNL K-1
 b. *Fire control matériel.*
 Board, plotting, sound ranging, M1----- SNL F-154
 Board, plotting, M5----- SNL F-202
 Corrector, wind, sound ranging, M1----- SNL F-153

2. Explanatory publications.

- a. Cleaning and preserving materials----- TM 9-850
 b. *Fire control matériel.*
 Firing ----- FM 6-40
 Matériel inspection and repair----- TM 9-1100

[A. G. 062.11 (2-10-42).]

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B 6 (2) ; R 6 (2) ; IBn 9 (1) ; IC 9 (3).
 (For explanation of symbols see FM 21-6.)

